U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 USC 371

ATTORNEY DOCKET NO: 210091

U.S APPLICATION NO: Unassigned 09/806739

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP99/07440	05 OCTOBER 1999 (05.10.99)	06 OCTOBER 1998 (06.10.98)

TITLE OF INVENTION
TESTING DEVICE FOR DETECTING AND LOCALIZING MATERIAL INHOMOGENEITIES

APPLICANT(S) FOR DO/EO/US
HINKEN, Johann H.; TAVRIN, Yuri

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 USC 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371.

3. ☒ This is an express request to begin national examination procedures (35 USC 371(f)).

4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).

5. ☒ A copy of the International Application as filed (35 USC 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☒ An English language translation of the International Application as filed (35 USC 371(c)(2)).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☒ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).

9. ☐ An oath or declaration of the inventor(s) (35 USC 371(c)(4)).

10. ☒ Copy the annexes and an English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)).

11. Nucleotide and/or Amino Acid Sequence Submission
    a. ☐ Computer Readable Form (CRF)
    b. Specification Sequence Listing on:
       i. ☐ CD-ROM or CD-R (2 copies); or
       ii. ☐ Paper Copy
    c. ☐ Statement verifying identity of above copies

Items 12 to 19 below concern other document(s) or information included:

12. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
    ☒ Form PTO-1449
    ☒ Copies of Listed Documents

13. ☐ An assignment for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

14. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.

15. ☐ A substitute specification.

16. ☐ A change of power of attorney and/or address letter.

17. ☒ Application Data Sheet Under 37 CFR 1.76

18. ☒ Return Receipt Postcard

19. ☒ Other items or information: Claims as Amended on April 4, 2001; Claims Pending as of April 4, 2001; Copy of International Search Report; Copy of Search Report from DE 198 46 025

U.S. APPLICATION NO.	INTERNATIONAL APPLICATION NO.	ATTORNEY DOCKET NO
Unassigned 09/806739	PCT/EP99/07440	210091

	CALCULATIONS	PTO USE ONLY
20. ☒ The following fees are submitted:		
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1,000.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... $ 860.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO, but international search fee (37 CFR 1.445(a)(2))paid to USPTO ..... $ 710.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)..... $ 690.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1) to (4) ..... $ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT=	$860.00	
Surcharge of $130.00 for furnishing the National fee or oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	18 -20=	0	x $ 18.00	$0.00	
Independent Claims	2 - 3 =	0	x $ 80.00	$0.00	
☐ Multiple Dependent Claim(s) (if applicable)			+$270.00	$	

TOTAL OF ABOVE CALCULATIONS=	$860.00	
☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.	$430.00	
SUBTOTAL=	$430.00	
Processing fee of **$130.00** for furnishing English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date.	$	
TOTAL NATIONAL FEE=	$430.00	
Fee for recording the enclosed assignment. The assignment must be accompanied by an appropriate cover sheet. **$40.00** per property +	$	
TOTAL FEE ENCLOSED=	$430.00	
	Amount to be refunded	$
	charged	$

a. ☒ A check in the amount of $430.00 to cover the above fee is enclosed.

b. ☐ Please charge Deposit Account No. 12-1216 in the amount of $ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 12-1216. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Customer Number: 23460

23460

PATENT TRADEMARK OFFICE

Carol Larcher, Registration No. 35,243
One of the Attorneys for Applicants

Date: April 4, 2001

U.S. APPLICATION NO.	INTERNATIONAL APPLICATION NO.	ATTORNEY DOCKET NO.
Unassigned	PCT/EP99/07440	210091

CERTIFICATION UNDER 37 CFR 1.10

"Express Mail" Label Number: EL643546055US

Date of Deposit: April 4, 2001

I hereby certify that this express request to begin national examination procedures under 35 USC 371(f) of the International Patent Application referenced above, including all of the items listed thereon as enclosures, is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to Box PCT, Assistant Commissioner for Patents, Attention: DO/EO/US, Washington, D.C. 20231.

Irina L. Mikitiuk — Printed Name of Person Signing:

I. Mikitiuk — Signature

PATENT
Attorney Docket No. 210091

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Hinken et al.

Art Unit: Unassigned

Application No. Unassigned
(U.S. National Phase of PCT/EP99/07440)

Examiner: Unassigned

Filed: April 4, 2001

For: TESTING DEVICE FOR DETECTING AND LOCALIZING MATERIAL INHOMOGENEITIES

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE CLAIMS:

Please cancel claims 1-11.

Please add the following new claims:

12. A testing device for detecting and localising material inhomogeneities in electrically conductive samples comprising a holder for the sample to be tested, a temperature setting device for forming a temperature profile in the sample, and at least one measuring sensor for the contactless measurement of the magnetic field outside the sample, wherein several measuring sensors are provided at a different distance to the sample.

13. The testing device of claim 12, wherein the holder is connected to a rotational drive for rotating the sample.

14. The testing device of claim 12, wherein the measuring sensors comprise a Squid sensor.

15. The testing device of claim 14, wherein the Squid sensor is a Squid magnetometer.

16. The testing device of claim 14, wherein Squid sensor comprises a Squid gradiometer.

17. The testing device of claim 13, wherein the measuring sensors comprise a Squid sensor.

18. The testing device of claim 17, wherein the Squid sensor is a Squid magnetometer.

19. The testing device of claim 17, wherein Squid sensor comprises a Squid gradiometer.

20. A method for detecting and localising material inhomogeneities in electrically conductive samples, wherein the sample is brought to a predetermined temperature profile and the magnetic field outside the sample is contactlessly measured, wherein the magnetic field outside the sample is measured with several measuring sensors which are provided at a different distance to the sample.

21. The method of claim 20, wherein the sample is rotated.

22. The method of claim 20, wherein from the polarity of the measuring signal and the direction of the temperature gradient one may infer the type of homogeneity.

23. The method of claim 21, wherein from the polarity of the measuring signal and the direction of the temperature gradient one may infer the type of homogeneity.

24. The method of claim 20, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

25. The method of claim 21, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

26. The method of claim 22, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

27. The method of claim 23, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

28. The method of claim 20, wherein, in subsequent measurements, the magnetic field is measured at different distances to the sample.

29. The method of claim 20, wherein one simultaneously measures with several measuring sensors.

REMARKS

The present application is the U.S. national phase of a PCT application. In the present Amendment, claims 1-11 are cancelled, and claims 12-29 are added. The claims have been amended to conform the claims to U.S. patent practice and to eliminate multiple claim dependencies. No new matter has been added by way of these amendments.

The application is considered to be in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If in the opinion of the

Examiner a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

Carol Larcher, Reg. No. 35,243
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Date: April 4, 2001

PATENT
Attorney Docket No. 210091

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Hinken et al.

Art Unit: Unassigned

Application No. Unassigned
(U.S. National Phase of PCT/EP99/07440)

Examiner: Unassigned

Filed: April 4, 2001

For: TESTING DEVICE FOR DETECTING AND LOCALIZING MATERIAL INHOMOGENEITIES

CLAIMS AS AMENDED ON APRIL 4, 2001

1. Canceled.

2. Canceled.

3. Canceled.

4. Canceled.

5. Canceled.

6. Canceled.

7. Canceled.

8. Canceled.

9. Canceled.

10. Canceled.

11. Canceled.

12. (New) A testing device for detecting and localising material inhomogeneities in electrically conductive samples comprising a holder for the sample to be tested, a temperature setting device for forming a temperature profile in the sample, and at least one measuring sensor for the contactless measurement of the magnetic field outside the sample, wherein several measuring sensors are provided at a different distance to the sample.

13. (New) The testing device of claim 12, wherein the holder is connected to a rotational drive for rotating the sample.

14. (New) The testing device of claim 12, wherein the measuring sensors comprise a Squid sensor.

15. (New) The testing device of claim 14, wherein the Squid sensor is a Squid magnetometer.

16. (New) The testing device of claim 14, wherein Squid sensor comprises a Squid gradiometer.

17. (New) The testing device of claim 13, wherein the measuring sensors comprise a Squid sensor.

18. (New) The testing device of claim 17, wherein the Squid sensor is a Squid magnetometer.

19. (New) The testing device of claim 17, wherein Squid sensor comprises a Squid gradiometer.

20. (New) A method for detecting and localising material inhomogeneities in electrically conductive samples, wherein the sample is brought to a predetermined

temperature profile and the magnetic field outside the sample is contactlessly measured, wherein the magnetic field outside the sample is measured with several measuring sensors which are provided at a different distance to the sample.

21. (New) The method of claim 20, wherein the sample is rotated.

22. (New) The method of claim 20, wherein from the polarity of the measuring signal and the direction of the temperature gradient one may infer the type of homogeneity.

23. (New) The method of claim 21, wherein from the polarity of the measuring signal and the direction of the temperature gradient one may infer the type of homogeneity.

24. (New) The method of claim 20, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

25. (New) The method of claim 21, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

26. (New) The method of claim 22, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

27. (New) The method of claim 23, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

28. (New) The method of claim 20, wherein, in subsequent measurements, the magnetic field is measured at different distances to the sample.

29. (New) The method of claim 20, wherein one simultaneously measures with several measuring sensors.

PATENT
Attorney Docket No. 210091

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Hinken et al.

Art Unit: Unassigned

Application No. Unassigned
(U.S. National Phase of PCT/EP99/07440)

Examiner: Unassigned

Filed: April 4, 2001

For: TESTING DEVICE FOR DETECTING AND LOCALIZING MATERIAL INHOMOGENEITIES

CLAIMS PENDING AS OF APRIL 4, 2001

12. A testing device for detecting and localising material inhomogeneities in electrically conductive samples comprising a holder for the sample to be tested, a temperature setting device for forming a temperature profile in the sample, and at least one measuring sensor for the contactless measurement of the magnetic field outside the sample, wherein several measuring sensors are provided at a different distance to the sample.

13. The testing device of claim 12, wherein the holder is connected to a rotational drive for rotating the sample.

14. The testing device of claim 12, wherein the measuring sensors comprise a Squid sensor.

15. The testing device of claim 14, wherein the Squid sensor is a Squid magnetometer.

16. The testing device of claim 14, wherein Squid sensor comprises a Squid gradiometer.

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20. A method for detecting and localising material inhomogeneities in electrically conductive samples, wherein the sample is brought to a predetermined temperature profile and the magnetic field outside the sample is contactlessly measured, wherein the magnetic field outside the sample is measured with several measuring sensors which are provided at a different distance to the sample.

21. The method of claim 20, wherein the sample is rotated.

22. The method of claim 20, wherein from the polarity of the measuring signal and the direction of the temperature gradient one may infer the type of homogeneity.

23. The method of claim 21, wherein from the polarity of the measuring signal and the direction of the temperature gradient one may infer the type of homogeneity.

24. The method of claim 20, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

25. The method of claim 21, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

26. The method of claim 22, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

27. The method of claim 23, wherein for the improved localization and shape determination of the inhomogeneity the temperature profile in the sample is differently set in subsequent measurements.

28. The method of claim 20, wherein, in subsequent measurements, the magnetic field is measured at different distances to the sample.

29. The method of claim 20, wherein one simultaneously measures with several measuring sensors.

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, JOHANN HINKEN of Innerste Au 34, D-31139 Hildesheim, Federal Republic of Germany and YURY TAVRIN of Bodenburger Strasse 25/26, D-31162 Bad Salzdetfurth, Federal Republic of Germany, both German citizens, have invented certain new and useful improvements in TESTING DEVICE FOR DETECTING AND LOCALIZING MATERIAL INHOMOGENEITIES of which the following is a specification:

BACKGROUND OF THE INVENTION

The invention relates to a testing device for detecting and localising material inhomogeneities in electrically conductive subjects or samples.

According to the state of the art, with the testing of electromagnetic inclusions the subject is premagnetized and subsequently scanned with a magnetic field measuring apparatus as published by J. Tavrin and by J. Hinken at the "7. Europäischen Konferenz für zerstörungsfreies Testen" (7th European Conference for non-destructive testing) in Copenhagen 1998 and in the document of the Institute Dr. Forster 04/95. By way of the scanning in at least two planes one may infer the depth position of the inclusions. With the testing for non-ferromagnetic inclusions or inhomogeneities the subject is brought into an external magnetic field, wherein this may also be the naturally present earth's field. On account of the succeptibility fluctuations in the subject the magnetic field outside the subject is location-dependent. With measurement with a magnetometer one may draw conclusions on the non-ferromagnetic inhomogeneities, as is known from the publication by J.P. Wikswo in IEEE Trans. Appl. Supercond., Volume 3, No. 1 of March 1993. Both measuring methods do not use a directed temperature change of the subject.

Thermoelectric effects were up to now only used for the sorting of similar materials, not for the detection and localization of inhomogeneities, as is known from a publication by McMaster in "Non-destructive Testing Handbook", Second Edition, Volume 4, Electromagnetic Testing of the American Society for Non-destructive Testing of 1996 and from a publication by A.S. Karolik and A.A. Lukhvich in Sov. J. Nondestruct. Test., Volume 26, No. 10 of October 1990. Furthermore for this an electrical and mechanical contacting of the component is necessary.

The apparatus for magnetic field measurement described according to the state of the art, i.e. based on the remanence and the succeptibility have the disadvantage that the measuring signals are not strong enough to ascertain and to quantify also small inhomogeneities lying far below the surface. Measuring apparatus with thermoelectric effects have not yet been used for the detection and localization of inhomogeneities.

BRIEF SUMMARY OF THE INVENTION

It is the object of the invention, with magnetic field-supported, non-destructive testing of electrically conductive subjects to intensify the magnetic field signals and thus to increase the measuring resolution. This applies to inhomogeneities close to the surface as well as to those which lie deep below the surface.

This object with regard to device technology is achieved by the features of claim 1, and with regard to the method technology by the features of claim 9.

On account of the temperature profile set in a sample by way of the temperature setting means, the magnetic field signals of the material of the probe, in particular the segregations, are increased in a manner such that material inhomogeneities may be detected and localized when the magnetic field outside the sample is measured during a position change. By way of this, material inhomogeneities on the surface and also deep below the surface of the sample may be detected in a non-destructive and exact manner.

The testing device according to the invention measures and tests in a non-destructive manner, wherein the device sets the temperature or the temperature gradient in the measured object in a targeted manner and measures the magnetic field outside the measured object. Characteristic magnetic field signatures arise on account of various physical effects. To these there belong temperature dependency of the succeptibility, thermoelectric effects and thermomagnetic effects.

Measuring signals which are based on succeptibility differences become stronger when this difference is greater. Now the succeptibility of many materials becomes larger with a reducing temperature. It is often roughly proportional to the inverse value of the absolute temperature. A cooling of the subject therefore increases the succeptibility of the base material and the inclusion and thus also the difference of both, as is known from the publication by W. Schultz "Dielektrische und magnetische Eigenschaften der Werkstoffe“ (Dielectric and magnetic properties of the materials), Vieweg, Braunschweig of 1970. With this the cooling is contrast-intensifying. This method based on the succeptibility difference permits the detection also of inhomogeneities lying deep below the surface.

Of the thermoeletric effects in this context amongst others the Seebeck effect and the first Benedicks effect are used, which are known from the publication by Joachim Schubert: "Physikalische Effect" (Physical effects), Physik publishing house , Weinheim 1984.

If two contact locations lie between two different materials at different temperatures, between them there arises an electrical voltage. This is the thermoelectric voltage, the effect is the Seebeck effect. In the component to be tested these contact locations are formed by the border layer between the base material and the inclusion. If a temperature gradient lies over the inclusion there is created the condition for the existance of thermoelectric voltages and thermoelectric currents. These currents in turn also outside the tested object produce a magnetic field which may be detected with a magnetic field measuring apparatus. The mentioned temperature gradient may be created by cooling or heating. The polarity of the produced magnetic field together with the polarity of the temperature gradient give indications as to the material class of the inclusions. The inclusions to be detected with this must be electrically conductive.

Fractures or insulating inclusions in otherwise homogeneous material may be detected by way of the first Benedicks effect. According to the Benedicks effect in a homogeneous conductor there arises a thermoeletric voltage when there is present a high temperature slope. This thermoeletric voltage in turn results in thermoelectric currents whose distribution is disturbed by fractures and insulating inclusions. Corresponding changes in the magnetic field which are produced outside the tested object by way of these currents may be detected.

According to the invention the thermoeletric effects are observed without creating an electrical and mechanical contact. This has the advantages that the errors by way of unreproducable contacts are avoided, that the components may be scanned with more degrees of freedom and that with this there are left no traces of scratches. This measuring method based on thermoelectric effects permits inhomogeneities lying deep below the surface to be detected.

Further advantageous embodiments of the invention are the subject-matter of the dependent claims.

With the use of the thermoelectric effects the temperature slope in subsequent measurements may be differently set in a targeted manner. The measuring signals resulting

therefrom give further information on the examined inhomogeneity, as e.g. an improved localization and shape detection.

BRIEF DESCRIPTION OF THE DRAWINGS

Further details, features and advantages of the invention result from the subsequent desription of one advantageous embodiment form of the invention by way of the drawings.

There are shown in

Fig. 1 a schematic representation of a testing device according to the invention;

Fig. 2 a graphic representation of a measuring signal of a sample, which has been determined by the testing device of Fig. 1; and

Fig. 3 a graphic representation of a measuring signal of a sample which has been determined by the testing device of Fig. 1.

DETAILED DESCRIPTION OF THE INVENTION

In Fig. 1 there is shown an advantageous embodiment example of a testing device for detecting and localising material inhomogeneities in a measured object or a sample 10, which in particular is pre-magnetized. The sample 10 is a circular disk which is carried by a short tube piece 21 which serves as a distancer and a cold bridge. The lower side of the tube 21 is cooled with cooling fluid, in particular liquid nitrogen. In the sample 10 itself thus there arises a temperature gradient, i.e. a temperature slope with which at the top there is present a higher temperature and at the bottom a lower temperature. The sample 10 is rotated and at its upper side the magnetic field is scanned with a magnetic field measuring apparatus or a gradiometer 20. As a magnetic field measuring apparatus there is used a Squid gradiometer 20 of the second order (HMT), as shown in Fig. 1, which measures the normal component of the magnetic field on the surface of the subject or of the sample 10. This magnetic field measuring apparatus 20 consists of three individual Squid sensors 22 which are manufactured of high-temperature superconductors. For operation they are filled with liquid nitrogen. The three sensors 22 and their

electronic channels are mechanically and electronically matched such that the background fields are extremely supressed. Only signals from the neighboring sample 10 are indicated, and specifically with a particularly high sensitivity. This measuring system thus does not require any magnetic shielding around the sample 10 and the sensors 22, as is otherwise often necessary with Squid measuring systems.

There are various cooling methods, as shown in Fig. 1, which are based on the use of a cooling fluid. With the use of a first method 50 the probe 10 is cooled over a large surface on the lower side, and there sets in a certain temperature slope in the sample 10. According to a second method 60 a tube piece 21 is cooled whose diameter may be suitably selected and varied. With the variation of the temperature slope, inhomogeneities present may be localized. The sample 10 may be measured from both sides by turning round. With this, mostly a polarity change and an amplitude change are expected. The gradiometer 20 or the cryostat with gradiometer, in particular with "epoxy dewar" or epoxy-pole has a height of approx. 800 mm, wherein the diameter of the lower part is approx. 90 mm. The gradiometer 20 may be varied in its height above the sample 10 in order in subsequent measurements to determine the depth of an inhomogeneity.

The three Squid sensors 22 are normally as desribed above, connected to a gradiometer 20 of the second order. In Fig. 1 three Squid sensors 22 are connected to an electronic device 40, wherein the electronic device 40 indicates a measuring result in $((d^2Bz)//dz^2))(t)$ as is indicated by the arrow leading away from the electronic device 40. This connecting may be simply changed so that the lower two and also the upper two Squid sensors 22 may in each case be connected to gradiometers of the first order. In this manner it is possible with these two magnetic field measuring apparatus to simultaneously measure at different distances to the sample 10 and furthermore to carry out a depth detection of inhomogeneities present.

The Figs. 2 and 3 show graphic representations of measuring signals which were recorded with a testing device of Fig. 1, wherein the disk consisted of a nickel base alloy Waspaloy with a disk diameter of approx. 180 mm and a disk thickness of approx. 40 mm. In the Figures 2 and 3 the x-axis indicates the rotational angle of the sample 10 between 0° and 360°, wherein the y-axis indicates the magnetic field strength in $(d^2Bz)//dz^2)$. On the surface, by way of segregation sets at an angle ϕ which represents the minimum of the graphs, a hard-α segregation was recognized and localized.

Fig. 2 shows a distinct measuring signal at the location of the segregation, created by currents which according to the Seebeck effect flow in the sample. In Fig. 2 the temperature gradient is set very greatly by which means the measuring signal is very distinctive.

Under conditions which are otherwise the same, Fig. 3 shows the measurement with a weakly set temperature gradient with a correspondingly less strong measuring signal with the minimum of the graphs at $\phi = 190°$.

CLAIMS

1. A testing device for detecting and localising material inhomogeneities in electrically conductive samples, comprising a holder for the sample to be tested;

a temperature setting device for forming a temperature profile in the sample;

a drive connected to the holder, for the position change of the sample;

at least one measuring sensor for the contactless measurement of the magnetic field outside the sample.

2. A testing device according to claim 1, wherein the temperature setting device sets a temperature gradient in the sample.

3. A testing device according to claim 1, wherein the temperture setting device sets a temperature profile in the sample which has a homogeneous, location-dependent constant temperature.

4. A testing device according to one of the preceding claims, wherein the temperature setting device is connected to the measuring sensor.

5. A testing device according to one of the preceding claims, wherein the holder is connected to the temperature setting device.

6. A testing device according to one of the preceding claims, wherein the measuring probe is movably or displaceably arranged.

7. A testing device according to one of the preceding claims, wherein the measuring sensor comprises a Squid magnetometer.

8. A testing device according to one of the preceding claims, wherein the measuring sensor comprises a Squid gradiometer.

9. A method for detecting and localising material inhomogeneities in electrically conductive samples, wherein the sample is brought to a predetermined temperature profile and the magnetic field outside the sample is measured.

10. A method according to claim 9, wherein the temperature profile has a temperature gradient.

11. A method according to claim 9 or 10, wherein from the polarity of the measuring signal and the direction of the temperature gradient one infers the type of inhomogeneity.

12. A method according to one of the claims 9 to 11, wherein for the improved localization and shape determination of the inhomogeneity, in subsequent measurements the temperature profile in the sample is differently set.

13. A method according to one of the cllaims 9 to 11, wherein the depth detection of the inhomogeneity is effected in that in subsequent measurements one measures at different distances to the sample.

14. A method according to one of the claims 9 to 11, wherein the depth detection of the inhomogeneity is effected in that with several measuring probes one simultaneously measures at different distances to the sample.

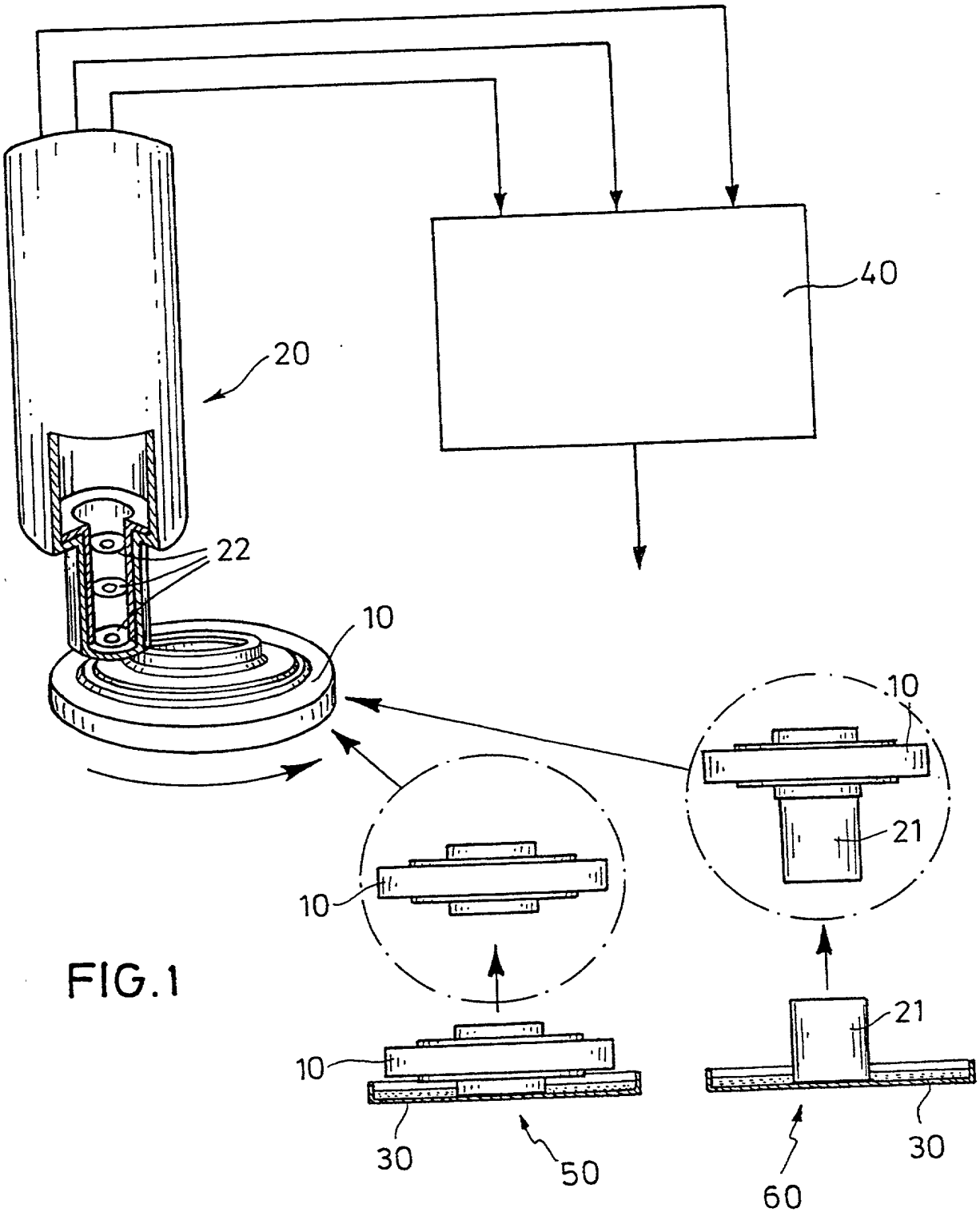


FIG.1

09/806739

FIG.3

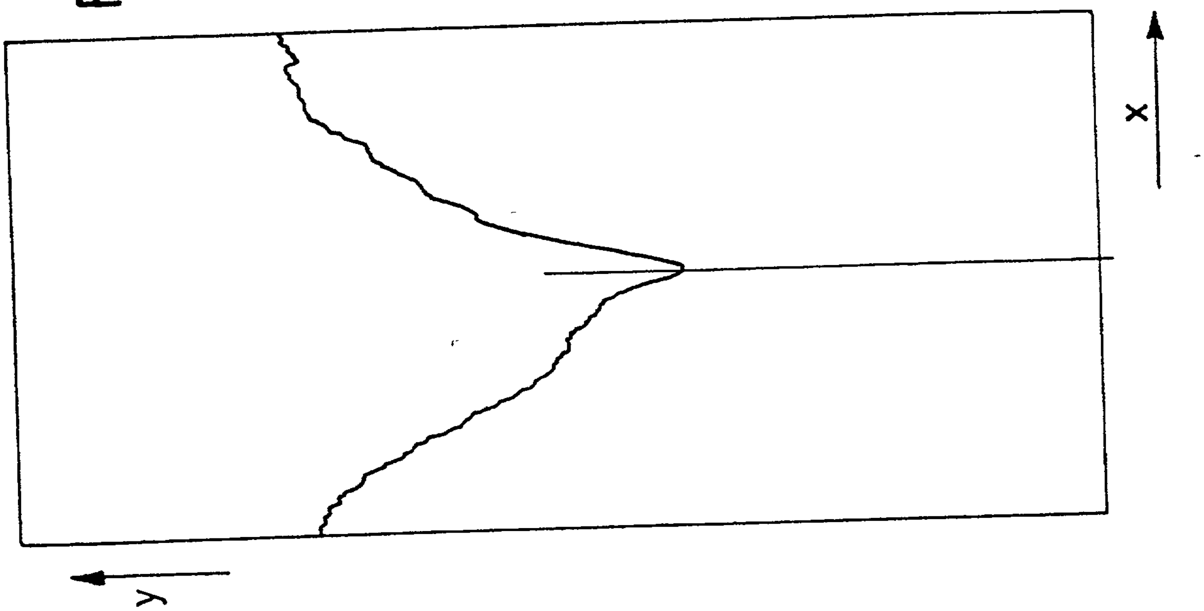
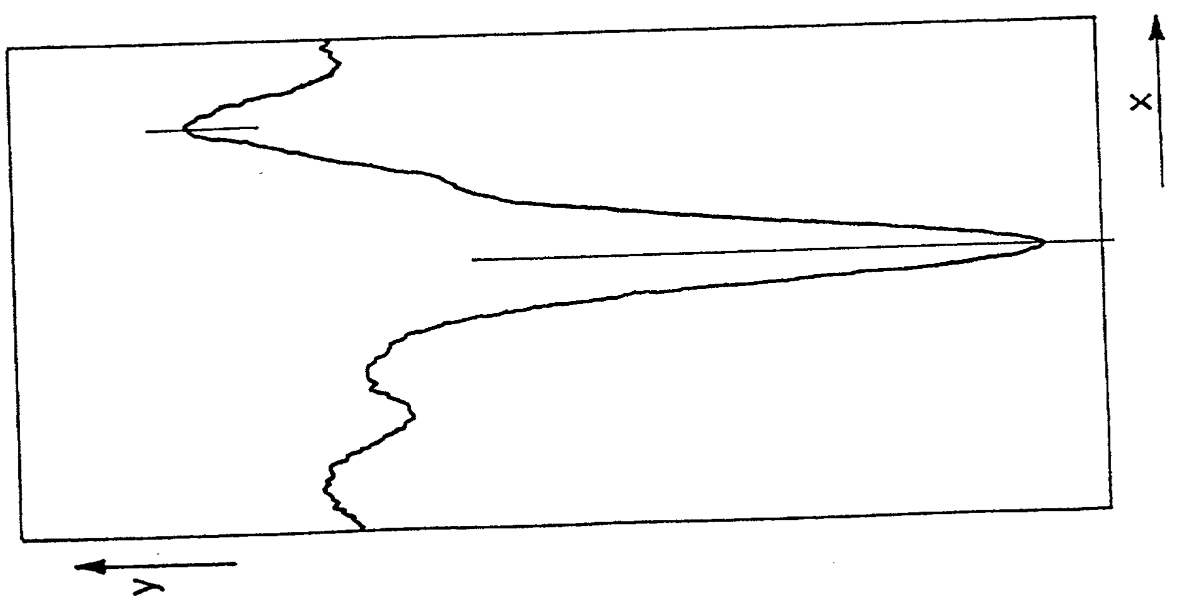


FIG.2



PATENT
Attorney Docket No. 210091

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

This declaration is of the following type:

☐ original ☐ design ☐ supplemental
☒ national stage of PCT
☐ divisional ☐ continuation ☐ continuation-in-part

My residence, post office address, and citizenship are as stated below next to my name. I believe I am the original, first, and sole inventor *(if only one name is listed below)* or an original, first, and joint inventor *(if plural names are listed below)* of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TESTING DEVICE FOR DETECTING AND LOCALIZING MATERIAL INHOMOGENEITIES

the specification of which:

☐ is attached hereto.
☒ was filed on April 4, 2001 as Application No. 09/806,739 and was amended on April 4, 2001 *(if applicable)*.
☐ was filed by Express Mail No. *as Application No. not known yet*, and was amended on *(if applicable)*.
☐ was filed on as PCT International Application No. PCT/ and was amended on *(if any)*.

I state that I have reviewed and understand the contents of the specification identified above, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information that is material to the patentability of the application identified above in accordance with 37 CFR 1.56.

I claim foreign priority benefits under 35 USC 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate or 365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent, utility model, design registration, or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter and having a filing date before that of the application(s) from which the benefit of priority is claimed.

PRIOR FOREIGN PATENT, UTILITY MODEL, AND DESIGN REGISTRATION APPLICATIONS						
COUNTRY	PRIOR FOREIGN APPLICATION NO.	DATE OF FILING (day,month,year)	PRIORITY CLAIMED			
Germany	198 46 025.2	06 October 1998	X	YES		NO
				YES		NO
				YES		NO

In re Appln. of Hinken et al.
Attorney Docket No. 210091

I claim the benefit pursuant to 35 USC 119(e) of the following United States provisional patent application(s):

PRIOR U.S. PROVISIONAL PATENT APPLICATIONS, BENEFIT CLAIMED UNDER 35 USC 119(e)	
APPLICATION NO.	DATE OF FILING (day,month,year)

I claim the benefit pursuant to 35 USC 120 of any United States patent application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this patent application is not disclosed in the prior patent application(s) in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose material information as defined in 37 CFR 1.56 effective between the filing date of the prior patent application(s) and the national or PCT international filing date of this patent application.

PRIOR U.S. PATENT APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S., BENEFIT CLAIMED UNDER 35 USC 120					
U.S. PATENT APPLICATIONS			Status *(check one)*		
U.S. APPLICATION NO.	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
1.					
2.					
3.					
PCT APPLICATIONS DESIGNATING THE U.S.			Status *(check one)*		
PCT APPLICATION NO.	PCT FILING DATE (day,month,year)	U.S. APPLICATION NOS. ASSIGNED (if any)	PATENTED	PENDING	ABANDONED
4. PCT/EP99/07440	05 October 1999	09/806,739		X	
5.					
6.					

DETAILS OF FOREIGN APPLICATIONS FROM WHICH PRIORITY CLAIMED UNDER 35 USC 119 FOR ABOVE LISTED U.S./PCT APPLICATIONS				
ABOVE APPLICATION NO.	COUNTRY	APPLICATION NO.	DATE OF FILING (day,month,year)	DATE OF ISSUE (day,month,year)
1.				
2.				
3.				
4. PCT/EP99/07440	Germany	198 46 025.2	06 October 1998	
5.				
6.				

In re Appln. of Hinken et al.
Attorney Docket No. 210091

As a named inventor, I hereby appoint Leydig, Voit & Mayer, Ltd. to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Customer Number 23460.

23460

PATENT TRADEMARK OFFICE

I further direct that correspondence concerning this application be directed to Leydig, Voit & Mayer, Ltd.: Customer Number 23460.

23460

PATENT TRADEMARK OFFICE

I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Johann F. HINKEN

Inventor's signature _____

Date 28. Jan. 2002

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In re Appln. of Hinken et al.
Attorney Docket No. 210091

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Full name of second joint inventor, if any: Yury TAVRIN

Inventor's signature _____

Date 28.01.2001

Country of Citizenship: Germany

Residence: Bonn, Germany DEX
(city/state or country)

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